

# Readmission Following Laparoscopic Sleeve Gastrectomy

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## ABSTRACT

**Background and Objectives:** Prior studies have established a 1.7–4.33% readmission rate for laparoscopic sleeve gastrectomy (LSG), a rate that falls within the reported range for other bariatric procedures. The current report describes the incidence of 30-day readmission after primary LSG procedures performed at a single bariatric center of excellence (COE) and examines factors that may be associated with readmission.

**Methods:** Data on 343 consecutive LSG operations performed from February 2010 to May 2014 by a single surgeon (PG) were analyzed. Patients readmitted within 30 d were compared to the remaining patients by using Student's *t* test for continuous variables and the  $\chi^2$  test for categorical variables.

**Results:** All LSGs were completed laparoscopically with no conversions to open procedures. There were no reoperations, leaks, perioperative hemorrhages, or mortalities. Twelve patients (3.5%) were readmitted; 1 was readmitted twice. There were no identified risk factors for readmission, including patient demographics, comorbidities, and perioperative factors. Notably, 7 (7%) readmissions occurred in the initial 100 patients and 5 (2%) in the remaining 243 patients ( $P = .04$ ). Clinical pathways were modified after the initial 100 patients; routine contrast esophagograms were no longer performed, and a 1-day routine postoperative stay was adopted. Operative time also decreased from  $94.2 \pm 23.8$  to  $78.2 \pm 20.0$  min ( $P < .001$ ).

**Conclusions:** Readmission rates after LSG remain in a range similar to those described for other laparoscopic bariatric procedures. Larger prospective studies are needed to identify patterns of complications and readmissions in patients undergoing LSG that may differ from other bariatric procedures.

**Key Words:** readmission, laparoscopic sleeve gastrectomy.

## INTRODUCTION

Laparoscopic sleeve gastrectomy (LSG) has gained popularity in recent years as the initial surgical weight loss procedure of choice, balancing weight loss and metabolic benefits with the morbidity of the operation. LSG accounted for 54% of all bariatric procedures in the United States in 2014.<sup>1</sup> Although the American Society for Metabolic and Bariatric Surgery (ASMBS) has recognized LSG as a safe and effective primary bariatric procedure since 2012, data regarding readmission rates and risk factors for readmission are scarce.<sup>2</sup>

Reported 30-day hospital readmission rates after bariatric surgery range from 0.7 to 16% depending on the type of surgery.<sup>3</sup> Initial studies of LSG reported higher risk-adjusted readmission and reoperation rates when compared with laparoscopic Roux-en-Y gastric bypass (RYGB).<sup>4</sup> Since those first reports, both surgeon and institutional experience have significantly increased. Recent publications have reported the post-LSG hospital readmission rate to be 3.8–4.33%, placing the procedure between the average rate of 1.7% for patients after laparoscopic adjustable gastric band placement (LAGB) and 6.5% for patients after RYGB.<sup>3–6</sup>

As national trends continue to shift increasingly in favor of LSG, more outcome data are needed to better inform patients, balance physicians' preferences, and potentially reduce healthcare expenditures. Presentation to the emergency department and subsequent readmissions after bariatric surgery lead to increased healthcare costs. The 2011–2014 ASMBS update extrapolated an 11.3% unplanned emergency department utilization rate nationally into an estimated \$26,659,186 in annual healthcare expenditures.<sup>7</sup> In a recent study of 38,776 patients who underwent primary bariatric surgery in New York State between 2010 and 2013, Telem et al<sup>8</sup> reported that emergency department visits within 30 d of the initial bariatric procedure resulted in inpatient admission 35% of the time. Taking into account multiple visits and readmissions, the

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authors suggested that the figure quoted by the ASMBS report may be an underestimation of the healthcare costs associated with readmission after bariatric surgery. Therefore, in addition to improving patient care, identifying modifiable risk factors for readmission could have a substantial impact on the utilization of healthcare resources and possible cost reduction.

The current report describes the incidence of 30-day hospital readmission after primary LSG procedures performed at a single bariatric center of excellence (COE) and examines factors that may be associated with readmission.

## METHODS

Data on 343 consecutive primary LSG operations performed from February 2010 through May 2014 by a single surgeon (PG), who was experienced with other types of laparoscopic bariatric procedures, were analyzed. All data including patient demographics, comorbidities, operative data, hospital stay, complications, recovery, and readmissions were collected and entered into a prospectively designed database. COE clinical pathways were followed consistently for all patients. All patients attended mandatory preoperative information seminars and detailed information about the surgery, hospital stay, and postoperative recovery were given to each patient. Understanding of the surgery and recovery process was documented with a competence test administered to every patient, and the results were corrected and discussed with each patient individually. All postoperative prescriptions including liquid opioid pain medications were given to patients at the time of the preoperative visit with instructions to obtain the medications before surgery. Emphasis was made on the necessity of maintaining postoperative hydration and progressive physical activity.

All procedures were performed using the Echelon Flex 60 (Ethicon Endo-Surgery, Cincinnati, Ohio, USA) powered endocutter over a 34-French gastric lavage tube, starting 4 cm from the pylorus and ending 1 cm to the left from the angle of His. All patients received intraoperative and postoperative subcutaneous heparin (5000 U). Patients were required and encouraged to ambulate within 2 hours after arrival on the medical floor from the recovery room, and every 4 hours afterward, until discharge. Patients readmitted to the hospital within 30 d were compared to the remaining patients by using Student's *t* test for continuous variables and the  $\chi^2$  test for categorical variables.

Clinical pathways were modified after the initial 100 patients: routine contrast radiograms were no longer per-

formed and a 1-day postoperative hospital stay was adopted in place of the prior 2-day stay. Patients also did not undergo routine postoperative laboratory testing unless their vital signs or symptoms warranted further evaluation. Patients were discharged after tolerating oral liquids and if they had stable vital signs with an expected progressive postoperative course. All patients were seen on follow-up with the operating surgeon within 5 to 12 days after surgery. All discharge instructions were communicated in person. Written instructions delineating the expected perioperative proceedings were given to the patients and their families, both during the preoperative visit and at the time of discharge.

## RESULTS

All LSGs were completed laparoscopically with no conversions to open procedures. No open bariatric procedures were performed during the study period. There were no reoperations, leaks, or perioperative hemorrhages and no postoperative mortalities were reported. Twelve patients (3.5%) were readmitted; all resolved their presenting clinical problems with conservative management during readmission hospital stays of 1 to 7 days (mean = 3.5). One patient was readmitted twice. Reasons for readmission were abdominal pain (*n* = 5), chest pain (*n* = 3), vomiting with dehydration (*n* = 3), shortness of breath (*n* = 2), pancreatitis (*n* = 1), portal vein thrombosis (*n* = 1), and myocardial infarction (*n* = 1). All readmitted patients were initially discharged home after a 1- to 3-day routine postoperative hospital stay (mean = 1.7). Readmissions occurred, on average, 15.9 d after surgery (range, 4–30). Neither patient demographics (age, weight, body mass index [BMI], race, sex, or insurance status), comorbidities (type II diabetes, hypertension, obstructive sleep apnea, depression, or arthritis), perioperative data (operating time, operative blood loss, volume of intraoperative intravenous fluids, or length of initial hospital stay), or other potential risk factors (preoperative serum c-reactive protein level [CRP], general well-being, total number of comorbidities, number of abdominal surgeries in the past), had statistically significant associations with readmission (**Table 1**). Notably, 7 (7%) readmissions occurred in the initial 100 patients and 5 (2%) in the remaining 243 patients (*P* = .04). Operative time also decreased significantly from (mean  $\pm$  SD) 94.2  $\pm$  23.8 to 78.2  $\pm$  20.0 min (*P* < .001).

## DISCUSSION

Readmission rates after LSG remain similar to those described for other laparoscopic bariatric procedures.<sup>9,10</sup> Although risk factors for readmission after other bariatric pro-

**Table 1.**  
Patient Demographics and Association With Readmission

	All patients	Readmitted	Not readmitted	<i>P</i>
Age, years*	46.1 ± 10.8	42.4 ± 8.0	41.6 ± 10.9	0.73
Ethnicity, n (%)				
African-American	178 (52)	10 (83)	168 (51)	0.37
Arabic	2 (1)	0 (0)	2 (1)	
Asian	1 (0)	0 (0)	1 (0)	
Hispanic	72 (22)	0 (0)	72 (22)	
Indian	1 (0)	0 (0)	1 (0)	
Caucasian	86 (25)	2 (17)	84 (26)	
Sex, n (%)				
Female	298 (87)	10 (83)	288 (87)	0.65
Male	43 (13)	2 (17)	41 (13)	
Insurance type, n (%)				
Private	203 (60)	5 (42)	198 (60)	0.24
Public	138 (40)	7 (58)	131 (40)	
Pre-op weight, lb*	282.6 ± 50.0	277.2 ± 37.9	282.82 ± 46.3	0.62
Pre-op BMI*	46.6 ± 6.1	47.1 ± 4.4	46.6 ± 6.1	0.72
Pre-op hypertension, n (%)	200 (59)	9 (75)	191 (58)	0.37
Pre-op diabetes mellitus, n (%)	140 (45)	5 (42)	135 (45)	0.80
Pre-op C-reactive protein*	11.8 ± 8.4	11.9 ± 5.9	11.8 ± 8.5	0.99
Previous surgeries, n*	1.1 ± 1.1	1.0 ± 0.9	1.1 ± 1.1	0.75
Operative time, min*	82.6 ± 22.2	88.9 ± 27.6	82.3 ± 22.0	0.43
Estimated blood loss, mL*	10.8 ± 12.4	9.1 ± 8.5	10.9 ± 12.5	0.50
Intravenous fluids, mL*	1740.8 ± 440.5	1691.7 ± 299.9	1742.7 ± 445.2	0.58
Discharged home, days*	1.6 ± 1.0	1.7 ± 0.6	1.6 ± 1.0	0.44

\*Data expressed as the mean ± SD.

cedures have been studied, few studies have attempted to delineate risk factors for readmission after LSG. One may presume that identification of risk factors for readmission after LSG would lead to improved preoperative patient education, operative planning, and postoperative monitoring.<sup>11</sup>

In the largest study of readmission after LSG, readmitted patients were more likely to have insulin-dependent diabetes (IDDM), chronic obstructive pulmonary disease (COPD), and hyperlipidemia (HLD), alone or in combination.<sup>9</sup> Readmitted patients also had a higher American Society of Anesthesiologists (ASA) classification that was supported by several other studies (**Table 2**).<sup>5,12</sup> Similarly, in a study of 22,139 patients who underwent RYGB, LAGB, and LSG, medical comorbidities associated with increased risk of readmission within 2 years included

congestive heart failure (CHF), COPD, diabetes mellitus (DM), rheumatoid arthritis (RA), substance abuse, psychoses, and depression.<sup>11</sup> In a study of 35,655 patients with LSG or RYGB, dependent functional status and DM were also risk factors for early readmission for both groups. Chronic steroid use and history of cerebrovascular accident (CVA) and transient ischemic attack (TIA) were risk factors for readmission exclusively after LSG.<sup>13</sup> Several studies have also suggested increased age to be an additional risk factor for readmission after bariatric surgery.<sup>11,12</sup> In the current study, we were unable to identify any specific patient factors that correlated with readmission.

With regard to operative risk factors for readmission after LSG, readmitted patients had lower rates of staple line reinforcement and higher rates of intraoperative drain

**Table 2.**  
Risk Factors for Readmission After Bariatric Surgery

Author	n	Time Frame	Procedure	Demographics	Comorbid Conditions	DVT/PE	LOS	Operative Factors
Sippey et al <sup>5</sup>	34,983	30 day	LSG RYGB	—	↑ BMI ASA 3/4 Steroids Smoking HTN Renal	—	—	—
Sethi et al <sup>9</sup>	1,257	30 day	LSG	—	IDDM COPD HLD ↑ ASA	—	LOS ≥ 3d	Drain  Hernia repair  ↓ Staple line reinforcement
Willson et al <sup>10</sup>	200	30 day	LSG	↑ Age	—	—	—	—
Telem et al <sup>11</sup>	22,139	2 year	RYGB LAGB LSG	Black race Female gender Age > 50 Medicare/ Medicaid	CHF COPD DM RA Substance abuse Psychoses Depression	—	—	LSG
Dorman et al <sup>12</sup>	26,002	30 day	LAGB	Disabled	BMI ≥ 60 Angina ASA 3/4	DVT PE	↑ LOS	Open
Dorman et al <sup>12</sup>	24,662	30 day	RYGB	—	—	—	↑ LOS	—
Khorgami et al <sup>13</sup>	17,101	30 day	LSG	—	DM Steroids CVA/TIA Dependent	—	↑ LOS	OR time Post-op complication
Khorgami et al <sup>13</sup>	18,554	30 day	RYGB	Hispanic race Black race	DM ↑ Creatinine Cardiac disease Dyspnea at rest Dependent	—	—	OR time LOA Splenectomy Post-op complication
Saunders et al <sup>14</sup>	1,939	1 year	Open RYGB RYGB LAGB	—	Asthma	—	LOS > 5 days	RYGB
Saunders et al <sup>15</sup>	2,823	30 day	Open RYGB RYGB LAGB	—	—	DVT	LOS > 3 days	> 120 min RYGB Open RYGB
Weller et al <sup>16</sup>	7,868	30 day	Open RYGB RYGB	Male	PUD Arrhythmia	—	↑ LOS	Surgeon volume Hospital volume

PUD, peptic ulcer disease.

placement, as well as concurrent incisional or umbilical hernia repair.<sup>9</sup> One study of patients who underwent LSG or RYGB established concomitant additional operative interventions, such as lysis of adhesions, to be a risk factor for readmission after RYGB, but not after LSG. Increased operative time, however, was a significant risk factor after both procedures.<sup>13</sup> The current study identified no operative risk factors for readmission, as all procedures were performed by a single surgeon with no variability in operative technique. However, the first 100 cases had a significantly longer operative time than the remaining 243. There were also no conversions to open procedures. Another study of LSGs performed at a community bariatric center also identified no operative risk factors for 30-day emergency department visits or readmissions.<sup>10</sup>

Several studies have established prolonged length of stay (LOS) to be a significant risk factor for readmission after all bariatric procedures. Sethi et al<sup>9</sup> established that an initial LOS of greater than 3 days correlates highly with readmission. Another study of 24,662 RYGB and 26,002 LAGB procedures identified LOS as a significant risk factor for readmission in both cohorts.<sup>12</sup> In a study of 30-day readmissions after bariatric surgery, Saunders et al<sup>14</sup> found LOS of 3 days or more to be an independent risk factor. They included open gastric bypass (open RYGB), laparoscopic RYGB, and LAGB in their study. In another study by the same group, LOS of over 5 days was a significant risk factor for readmission within 1 year after surgery. In a study of 17,101 LSG and 18,554 RYGB cases, increased LOS was a risk factor for readmission in both cohorts.<sup>12</sup> The current study did not establish increased initial LOS to be a significant risk factor for readmission, although patients included in a modified clinical pathway with a routine 1-day postoperative stay were less likely to be readmitted.

Although LOS has been established in several studies as a significant risk factor for readmission, few studies have examined specific postoperative complications that may account for this increased risk. In a study of LAGB, Dorman et al.<sup>11</sup> showed that postoperative deep vein thrombosis (DVT) and pulmonary embolism (PE) are significant risk factors for readmission. Saunders et al<sup>15</sup> also reported the presence of postoperative DVT as a risk factor for 30-day readmission after bariatric surgery. Khorgami et al<sup>12</sup> found that any adverse event in the index admission was associated with a 2.6-fold increase in early readmissions. These complications include DVT and PE, although they were not specifically categorized by the study.

Increased surgeon and institutional experience may result in a further decrease in readmission rates after LSG. In a

study of 7,868 open and laparoscopic RYGB procedures, Weller et al<sup>16</sup> established that patients operated on by surgeons with a low volume of procedures ( $\leq 25$  procedures per year) were more likely to be readmitted, with a 28.4% readmission rate. Patients operated on by surgeons with a high volume ( $>150$  procedures per year) had a 7.3% readmission rate, compared with 3.1% for patients operated on by medium-volume surgeons (26–150 procedures per year). It is possible that surgeons with high volume operate on higher risk patients and perform a greater number of revisional procedures. Institutional experience was also shown to influence readmission rates as patients were more likely to be readmitted if their operations were performed at a hospital with a low volume of such procedures. For this reason, bariatric COEs such as the study hospital have been developed as high-volume centers with specialized care.

No prior studies have established whether changing the clinical pathway to encourage early discharge has decreased the rate of readmissions, although a recent study of 95,294 patients who underwent RYGB, LSG, or LAGB established that discharge on postoperative day 1 was associated with significantly reduced readmission rates in contrast to the previous notion that early discharge would lead to greater readmission.<sup>17</sup> Another study established that enhanced recovery for patients who underwent LSG involved decreased LOS but did not change the rate of readmission. The enhanced recovery pathway included standardized education, early ambulation, early oral intake, and prophylactic steroids and intraperitoneal antibiotics.<sup>18</sup> In the postoperative clinical pathway adopted since the inception of LSG operation at the study hospital, patients were encouraged to ambulate in the recovery room or immediately upon return to the medical floor on the day of surgery with a routine 2-day postoperative stay. Preoperative education was also standardized, although no prophylactic steroids or intraperitoneal antibiotics were given. The clinical pathway was modified after the first 100 patients, to encourage discharge on postoperative day 1. Routine laboratory testing was stopped, and contrast esophagograms were no longer routinely obtained on postoperative day 1. Patients were started on a clear liquid diet early on postoperative day 1, and 74% were discharged later that afternoon unless specific clinical findings or patient request mandated an additional day of hospital monitoring. Patients included in the modified clinical pathway were subsequently less likely to be readmitted.

Although the current study establishes that modifying the clinical pathway to encourage early discharge leads to



decreased readmission rates, there are several limitations. First, all procedures were performed by a single, experienced surgeon. Differences in operative technique are therefore difficult to assess. Second, all procedures were performed at a high-volume bariatric surgery COE. Therefore, the results of the current study may not be broadly applicable to other institutions. Larger, more detailed, multicenter prospective studies are needed to determine global risk factors for readmission after LSG and how they can be modified. Third, with only 343 patients, the current study may be inadequately powered to identify comorbidities and patient demographics that are risk factors for readmission. Finally, randomized prospective trials are needed to determine whether modification of postoperative clinical pathways will lead to a decreased 30-day readmission rate after LSG.

## CONCLUSION

Although several retrospective studies have established risk factors for readmission after bariatric surgery in general, published literature on readmissions after LSG is limited. Although risk factors such as initial LOS likely correlate across bariatric procedures, risk factors related to operative technique, surgeon experience, clinical pathways, and postoperative complications may be specific to LSG. Therefore, further prospective studies are needed to identify patterns of complications and causes for readmission in patients who have had LSG that may differ from those causing readmission after other bariatric procedures.

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